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ALTERING SYSTEM THERMAL PROFILES FOR PERFORMANCE ENHANCEMENT IN RESPONSE OF PRESSURE SENSOR READINGS

HP INC

Altering System Thermal Profiles for Performance Enhancement in Response of Pressure Sensor Readings

Abstract

In this disclosure, we would like to propose an idea of using pressure sensor(s) to determine whether the laptop is being placed on top of the desk, the possibility of the user touching on the c-cover is eliminated. As a result, a more aggressive thermal profile can be adopted to boost system performance.

Background

Heat stress or even heat injuries might occur when the accumulation of the heat inside of the body exceeds the dissipate capacity. Conventional thermal profiles of electronic devices typically make conservative assumptions that the user is touching the device surface all the time, to prevent heat stress to occur. As a result, a restrictive thermal profile is adopted, which may limit the performance of the entire system.

In our years of R&D experiences, on prevailing laptop designs, D-cover temperature is more inclined to hit the pre-defined warning threshold. The content of this disclosure intends to identify the situation that when a user's touch should be considered and when can be ignored. So that the system performance can be further accelerated while a user's touch can be ignored. There are probably some other solutions to detect whether the user is in front of the laptop via webcam or TOF camera, but we don't find a prior art that could decently tackle the problem like this solution does.

Invention Description

Nowadays the prevailing electronic devices adopts various thermal profiles under different use case scenarios. For one physical example, laptop devices may adopt Intel's 'Dynamic Platform and Thermal Frameworks' (DPTF) solution to switch and manage different thermal profiles under different use modes, such as clamshell, tablet, tent, or closed-display modes.

With regard, to each thermal profile, there are quite a few thermal indexes that are being tracked for maneuver device performance across the components to control the heat generated. The indexes may be CPU temperature, GPU temperature and/or skin temperature of the device surfaces but not limited to. Among those thermal indexes, based on our R&D experiences over the year, skin temperature on D-cover is more inclined to hit the pre-defined warning threshold. As a result, this thermal index becomes a bottleneck that impacts system performance.

In the following paragraph, we would like to describe an idea of using a pressure sensor integrated into a laptop's rubber feet, as Fig. 1 shows, for device displacement detection. By processing the values coming back from the pressure sensor, the system could infer if a user contact can be ignored or not. If a user's contact to the D-cover is not possible, a more aggressive thermal profile can be selected to boost the performance of the electronic device. In this disclosure, we will focus more on the laptop placement detection especially on clamshell mode and fully folded mode since the D-cover of the laptop device is not accessible to a user when the device is being placed up-right on top of the desk, as Fig. 2 shows.

Referring to Fig. 3 for a physical example of the stacking structure of the laptop chassis, pressure sensor and the rubber feet. The pressure sensor is being placed between the laptop chassis and the rubber feet, for detecting the pressure/weight (will be referred as p_{raw} in the following paragraph) of the rubber feet that it takes on.

Now move to Equation1, illustrates a normalized pressure value calculation example to be used in this disclosure. The normalization calculation is being used for processing the P_{raw} value read back from the pressure sensor to reveal the feature numbers for laptop placement circumstances determination. The relationship between the normalized pressure feature number and the placement circumstances will be detailed in the following sections.

Fig. 4 provides a sectional view of the laptop device from the rubber feet to the components above it. Due to the inequality of the weights of the components within the laptop chassis, the read back raw pressure/weight values,$P_{R(1)}$, $P_{R(2)}$...$P_{R(n-1)}$ and $P_{R(n)}$ of each sensing unit of the sensor are not even. In one implementation, $P_{R(1)}$, $P_{R(2)}$...$P_{R(n-1)}$ and $P_{R(n)}$ can be chosen as $P_{ZeroingCoefficient}$ that are mentioned in Equation 1, serving as an offset to shift the P_{raw}.

It is to be understood that $P_{ZeroingCoefficient}$ might vary with respect to the laptop hardware (component) changes, especially when the central mass of the device is being altered. There are several ways for the electronic device to tackle this issue. One method is to calibrate the device at the manufacturing line when the electronic device is being fully assembled. Evaluate and record the pressure readings by placing the fully assembled device on a horizontal desk surface. In another method, various $P_{ZeroingCoefficient}$ recipes corresponding to various hardware configurations may be saved in system NVRAM. When the system is powering on, the BIOS can select and apply the corresponding $P_{ZeroingCoefficient}$ based onthe hardware being detected on the system.

By using the normalization process as Equation 1 demonstrates, the pressure-sensing model we proposed here could cancel the hardware variances effects among different laptops. As a result, a hardware independent algorithm can be applied across different laptop models. In the following paragraph, we will show the capabilities of the pressure sensing predictive model regardless of laptop hardware.

Fig. 5 shows an example that the laptop is being placed on a uniform desk surface upright. By applying the normalization process as Equation 1 to the read back raw pressure values, the consequence, $P_{Normalized(i)}$ are all zeros.

Fig. 6 provides another example of another circumstance; the laptop is not contacting any desk surface, such as being held by a user's hand. By applying the normalization process as Equation 1 to the read back raw pressure values, the consequence, $P_{Normalized(i)}$ are minus 1 (-1).

Fig. 7, provides another scenario of the laptop placement, being placed on top of lap. Under the circumstance, there are only 2 contact points between the laptop rubber feet and lap. As the line chart shows, all the sensor without touching would take no weight, so the reading of those idle sensors are all 0s. On the other hand, there are 2 peaks (which would normally exceed 1.0) that can be found in the chart. That's because those lap-contacting pressure sensors would typically need to share the extra weights that the other idle sensors are unable to take.

Fig. 8, the 4th scenario, the laptop is being placed on a tilted plane. The normalized pressure value would fall within a range [0, -1], since the tilted angle decreases the gravity that the laptop takes.

Fig. 9, the 5th scenario, the laptop is being placed upright while a user is typing at the same time. In general, the normalized pressure on scenario 5 is very close to scenario 1, the only difference is that the normalized pressure measured on scenario 5 would be slightly higher since the sensors take the weight of the user's wrist as well as typing force.

The placement scenario illustrated above may be combined with various Intel DPTF use-modes (such as clamshell tablet and closed-display modes. etc.) to realize more delicate thermal profiles for better performance. For one physical example, if a laptop is being used in clamshell mode under placement scenario 1: placed on a horizontal plane, the possibility of user's touching the D-cover of the laptop can be ignored. As a result, the system might be programmed to switch to a more aggressive thermal profile which is more tolerant to the skin temperature of the D-cover for enhancing the system performance. On the other hand, for placement scenario 2 and 3, due to the possibility of the user touching the D-cover cannot be fully eliminated, the skin temperature threshold on the D-cover still needs to be kept at a conservative level to protect users. Similarly, on laptop placement scenario 5, due to the user's typing activity being detected, skin temperature threshold on C-cover will need to be protective to prevent injuries.

Fig. 10 provides an example of how the laptop placement scenario could be integrated with various use-modes for selecting different DPTF profiles on a laptop device. It is to be noted that the step, 'use-mode detection' might involve multiple various sensors' input to make the proper decision, includes but not limited to: gyroscope for device orientation detection, hall sensor for display open/close detection. etc. Since those use mode detection are matured features available on prevailing laptop devices on the market. So, we treat it as a prior art, skipping illustrating the details in this disclosure.

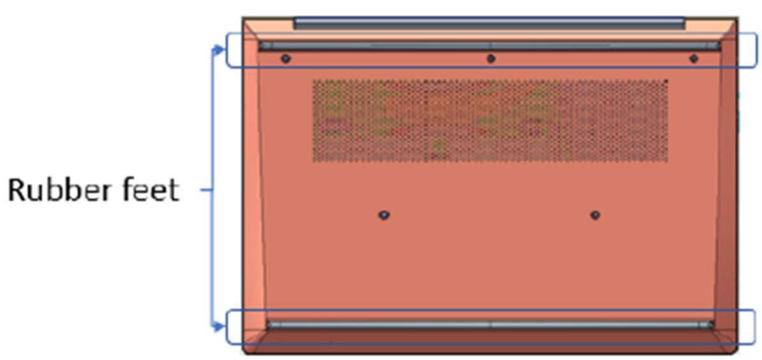

Fig. 1 D-Cover Rubber Feet

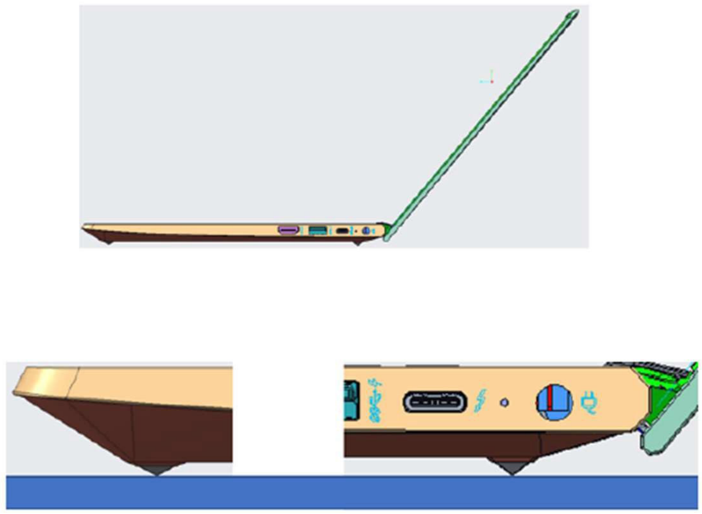

Fig. 2 Laptop Placed- On Desk In Clamshell Mode.

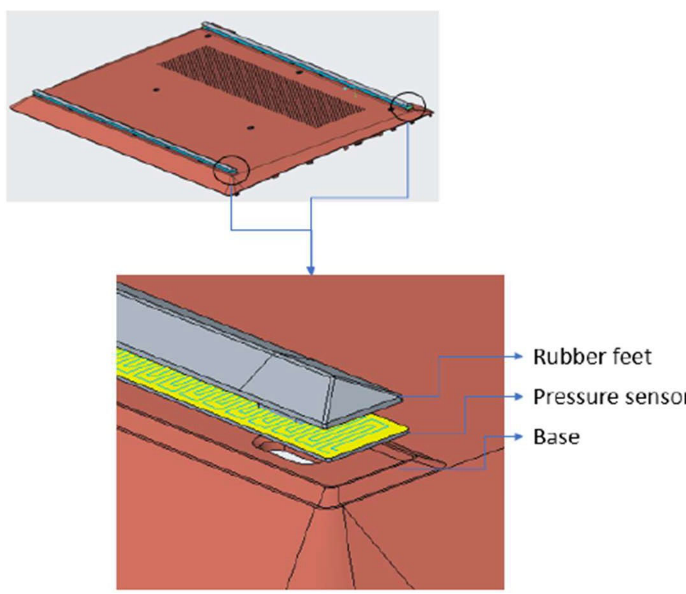

Fig. 3 Pressure Sensor Component Stacking

$$P_{normalized} = (P_{raw} - P_{ZeroingCoefficient})/P_{ZeroingCoefficient}$$

Equation 1 Pressure Value Normalization.

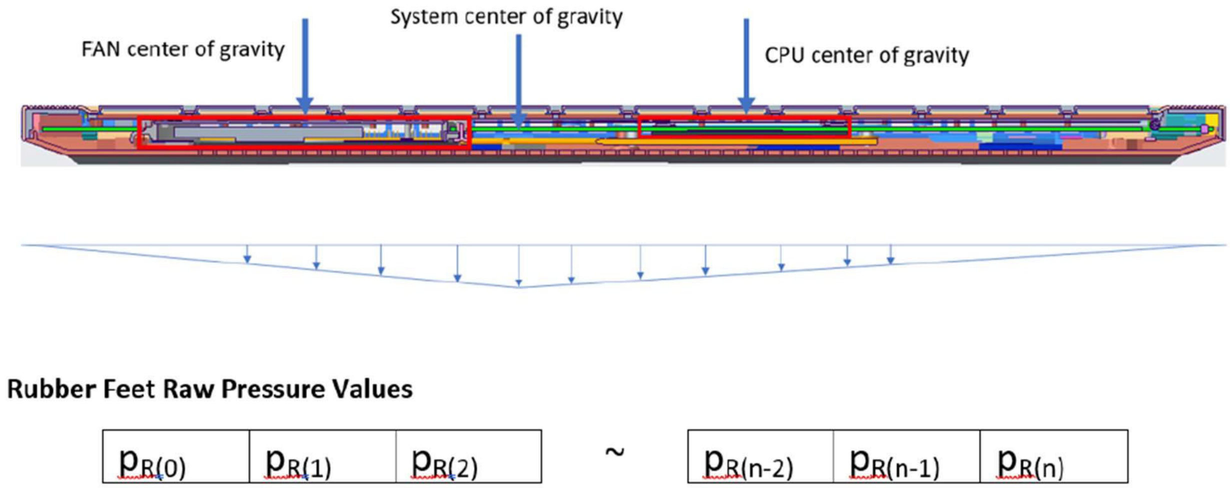

Fig. 4 Laptop Sectional View and Sensed Pressure P_{Raw}

Advantages

- An elegant and accurate process detects the laptop placement scenario via a normalized pressure sensor values, the determination principles can be applied to all the laptops, regardless of hardware variances.
- Compared with other user contact detection alternatives, such as image based, TOF camera-based alternatives, the pressure sensor-based solution is very power efficient, significantly requiring less computation resources from the host PC.
- The laptop placement scenario detection can be further integrated with Intel DPTF technology for more delicate thermal profile switching under the scenarios. As a result, the overall systemperformance increases.

Disclosed by Frank Cheng / Danny Ding, HP Inc.